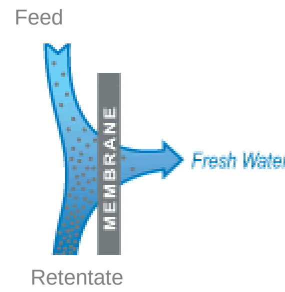
Microfiltration (MF) and Ultrafiltration (UF)

Microfiltration (MF) and Ultrafiltration (UF) are filtration processes that operation on a physical sieving separation process. They are best used for the removal of suspended solids, *Giardia*, C*rypotsporidum* and the reduction of turbidity. They are also used as a pretreatment to desalination technologies such as nanofiltration and reverse osmosis.



1.0 Applicable Contaminants

Both MF and UF are not currently listed as a BAT, but are widely used in the industry.

2.0 Description of Technology

MF has the largest pore size (0.1 – 3 microns) of the wide variety of membrane filtration systems. UF pore sizes range from 0.01 to 0.1 micron. In terms of pore size, MF fills in the gap between ultrafiltration and granular media filtration. In terms of characteristic particle size, this MF range covers the lower portion of the conventional clays and the upper half of the range for humic acids. This is smaller than the size range for bacteria, algae and cysts, and larger than that of viruses. MF is also typically used for turbidity reduction, removal of suspended solids, giardia and cryptosporidum. UF membranes are used to remove some viruses, color, odor, and some colloidal natural organic matter [1]. Both processes require low transmembrane pressure (1–30 psi) to operate, and both are now used as a pretreatment to desalination technologies such as reverse osmosis, nanofiltration, and electrodialysis [1].

MF membranes can operate in either crossflow separation or dead-end filtration. Cross flow separation is where only part of the feed stream is treated and the remainder of the water is passed through the membrane untreated. In dead-end separation, all of the feed water is treated. There are also two pump configurations, either pressure driven or vacuum-type systems. Pressure driven membranes are housed in a vessel and the flow is fed from a pump. Vacuum-type systems are membranes submerged in non-pressurized tanks and driven by a vacuum created on the product side. Typical recoveries can range from 85% to 95% [2]. Flux rates range from 20 to 100 gpd/ft^2 depending on the application. Backwashes are usually carried out for short durations (3 to 180 s) and occur in relatively frequent intervals (5 min to several hours) [2]. The frequency and duration depend on the specific application. A clean in place (CIP) can also be performed as a periodic major cleaning technique. Typical cleaning agents are sodium hypochlorite, citric acid, caustic soda and detergents. They can be initiated manually, and automatically controlled. CIP's occur when backwashing and chemically enhanced backwashes are not sufficient enough.

Factors influencing membrane selection are, cost, percent recovery, percent rejection, raw water characteristics, and pretreatment requirements.

Factors influencing performance are raw water characteristics, trans-membrane pressure, temperature, and regular monitoring and maintenance.

Pretreatment A self backwashing 100 um strainer is often necessary to protect the membranes and moderate particulate loading. Depending on the raw water, a coagulant such as ferric chloride may be added to form pinfloc and help improve rejection.

Maintenance It is necessary to monitor filtrate turbidity to give a rough indication of membrane integrity. Membrane integrity can be tested through a pressure decay test. In this test, pressurized air is applied to the membranes at a pressure less than would cause the air to flow through the membrane, and the pressure decay is measured. Regular monitoring of membrane performance is necessary to ensure the membrane system is operating at the most effective loading rate and backwash regime. Membrane life is typically estimated at 7+ years with manufacturer warranties covering 5 years.

Waste Disposal Waste includes pretreatment waste, backwash flow, retentate flow (if applicable), and CIP waste. Waste streams are either discharged to the sewer or treated if discharging to surface waters. Waste streams being discharged to surface waters are typically processed for turbidity removal through settling ponds or other treatment systems. CIP waste is neutralized and usually combined with the rest of the waste.

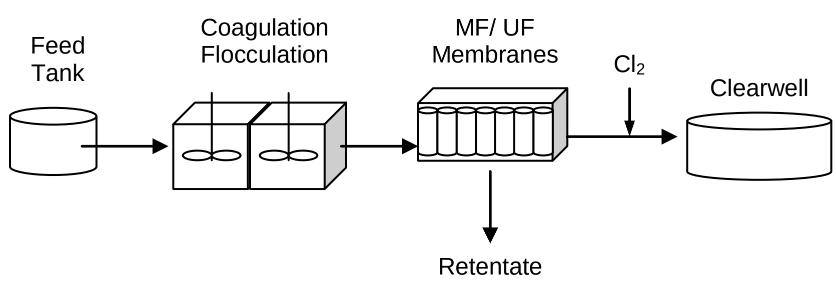
Benefits

- A low pressure process
- Can typically produce water of satisfactory turbidity with feed waters exceeding 100 NTU.
- MF and UF can receive state removal credits for *Giardia* and viruses up to 3 log and 4 log, respectively. However, virus removal is typically 0.5 log or less due to the smaller pore size of MF and UF.[3]

Limitations

- Membrane integrity and testing protocols are still under development.
- Some regulatory agencies are slow to accept MF applications.

3.0 Example Treatment Train



4.0 Safety and Health Concerns

- Concerns with high water pressures
- Electrical concerns

5.0 References

1. Trussell Technologies. "Desalination Technologies". Pasadena, 2008. Trussell Technologies. 6/11/2008. <http://www.trusselltech.com/tech_desalination.asp>.
2. American Water Works Association, and American Society of Civil Engineers. Water Treatment Plant Design. Ed. Edward E. Baruth. Fourth ed. New York: McGraw-Hill Handbooks, 2005.
3. United States Environmental Protection Agency (2005). Technologies and Costs Document for the Final Long Term 2 Enhanced Surface Water Treatment Rule and Final Stage 2 Disinfectants and Disinfection Byproducts Rule. Office of Water, United States Environmental Protection Agency.

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